## The Claims

What is claimed is:

1. A planar motor comprising:

a magnet array having a plurality of magnets;

a coil array having a plurality of coils;

a control system configured to selectively provide electric current to the coil array for translational movement in two degrees of freedom and rotation in a third degree of freedom, said current being controlled to at least substantially reduce force and torque ripple in said movement.

2. The planar motor of claim 1, wherein the coil array is square.

3. The planar motor of claim 2, wherein the coil array comprises sixteen coils.

4. The planar motor of claim 2, wherein the control system comprises one amplifier for each coil.

5. The planar motor of claim 1, wherein the magnet array is disposed about a magnet plane and the translational movement occurs in directions substantially parallel to the magnet plane.

6. The planar motor of claim 5, where the directions are substantially orthogonal to one another.

7. The planar motor of claim 6, wherein the directions are the x-direction and y-direction, a plurality of coils disposed parallel to the x-direction define a row and a plurality of coils disposed parallel to the y-direction define a column, the coils in each row and each column producing a torque that follows the relationship $12I_t k_a$, where $I_t$ is the current and is the magnetic force constant of a coil.

8. The planar motor of claim 6, wherein the directions are the x-direction and y-direction, current supplied to the coil array for translational movement

follows the relationship $\frac{F_n}{4k_a}$, and wherein $F_n$ is the component of force in the x-direction or the y-direction and $k_a$ is the magnetic force constant of a coil.

9. The planar motor of claim 6, wherein the directions are the x-direction and y-direction, current supplied to the coil array for torque follows the relationship $\frac{Torque_n}{12k_a}$, and wherein $Torque_n$ is the component of torque from one or more coils in a x-direction or a y-direction and $k_a$ is the magnetic force constant of a coil.

10. The planar motor of claim 1, wherein the control system compensates for undesired torque.

11. The planar motor of claim 10, wherein the undesired torque is a sinusoidal function.

12. The planar motor of claim 11, wherein the sinusoidal function is compensated by a negative of the sinusoidal function.

13. The planar motor of claim 1, wherein current applied to the coil array produces a force for the translational movement that is a function of the product of the current and a force constant.

14. The planar motor of claim 1, wherein current applied to the coil array produces a torque that is a function of the product of the current and a force constant.

15. A lithographic instrument comprising:

a positioning stage;

a planar magnet array;

a planar coil array coupled to the positioning stage;

a control system configured to selectively provide electric current to the coil array for translational movement in two degrees of freedom and rotation in a third degree of

freedom, said current being controlled to at least substantially reduce force and torque ripple in said movement.

16. A method for controlling a planar motor for positioning in three degrees of freedom, the method comprising:

positioning a movable coil array over a fixed magnet array, the coil array having coils generally disposed in a plane defining first and second directions that are substantially orthogonal to one another, and the magnet array having magnets with magnetic fields;

determining currents to be applied to coils to generate substantially ripple free translational forces between the coil array and the magnet array in the first and second directions and substantially ripple free torque about a third direction perpendicular to the plane;

applying currents as determined to the coils to move the coils.

17. The method of claim 16, wherein the determining currents comprises determining compensating currents required to compensate for undesired force and torque.

18. The method of claim 17, wherein the undesired torque is a sinusoidal function and the compensating currents are the negative of the sinusoidal function.

19. The method of claim 18, wherein the undesired torque follows the relationship $-12k_a I_x \sin\left(\pi pt_y\right)$, wherein $k_a$ is the magnetic force constant of a coil, $I_x$ is the current, and $pt_y$ is the pitch.

20. A system for controlling a planar motor, said motor including an array of coils for producing translational forces in two degrees of freedom, said system comprising :

a controller;

a sensor for sensing position of the coils;

a first comparator for receiving position feedback from the sensor; and

a second comparator for receiving input from a position disturbance in a third degree of freedom,

wherein said controller at least substantially applies a compensation function to said position disturbance and provides a corrected output position.

21. The processor of claim 20, wherein the controller comprises at least two amplifiers.

22. A planar motor comprising:

magnet array means;

coil array means; and

control means providing electric current to said coil array means for controlled movement in three degrees of freedom including means for at least substantially eliminating ripple.

23. A stage system comprising:

a planar motor, said planar motor comprising a magnet array having a plurality of magnets, a coil array having a plurality of coils, and a control system configured to selectively provide electric current to the coil array for translational movement in two degrees of freedom and rotation in a third degree of freedom, said current being controlled to at least substantially reduce force and torque ripple in said movement.

24. An exposure apparatus comprising:

an illumination system that supplies radiant energy; and

a stage system comprising a planar motor, said planar motor comprising a magnet array having a plurality of magnets, a coil array having a plurality of coils, and a control system configured to selectively provide electric current to the coil array for translational movement in two degrees of freedom and rotation in a third degree of freedom, said current being controlled to at least substantially reduce force and torque ripple in said movement,

wherein said stage system carries at least one object disposed on a path of said radiant energy.

25. A device manufactured with the exposure apparatus of claim 24.

26. A wafer comprising an image, wherein said image is formed with an exposure apparatus comprising:

an illumination system that supplies radiant energy; and

a stage system comprising a planar motor, said planar motor comprising a magnet array having a plurality of magnets, a coil array having a plurality of coils, and a control system configured to selectively provide electric current to the coil array for translational movement in two degrees of freedom and rotation in a third degree of freedom, said current being controlled to at least substantially reduce force and torque ripple in said movement,

wherein said stage system carries at least one object disposed on a path of said radiant energy.